SOILHEALTH1: SOIL HEALTH: CURRENT STATUS AND FUTURE NEEDS

PROGRAM FOR TUESDAY, OCTOBER 8TH

09:00-11:00 Session S3: Soil Health Status and Restoration

CHAIRS: *Marie Muehe* and *Nicholaos Danalatos*
LOCATION: Amphitheater Aristotle

09:00 *Nikos Nikolaidis*
Towards Integrated Water and Land Management: The Water-Ecosystem-Food Nexus and Nature-Based Solutions

ABSTRACT. Towards integrate water and soil management

09:45 *Dimitrios Bartzialis*, *Gerasimos J. Danalatos*, *Ippolytos Gintsioudis*, *Kyriakos Giannoulis* and *Nikolaos Danalatos*
Long Term Impacts of Land Use (Annual vs. Perennial Crops) and Sustainable Land Management Practices on Soil Quality Indices in Vulnerable Mediterranean Agroecosystems
PRESENTER: *Nikolaos Danalatos*

ABSTRACT. Land degradation and desertification threatens most of the sloping soils in the semi-arid regions of the Mediterranean zone. In Greece, the rate of degradation and abandonment of sloping soils under winter cereal monocultures (mainly wheat and barley) has been 200.000 ha per decade for the last 5 decades. Soil quality assessment is valuable for evaluating agroecosystem sustainability, soil degradation, and identifying sustainable land management practices. The present study focuses on the long-term impacts of land use (perennial vs annual crops) and sustainable land management practices on soil quality indices in vulnerable agroecosystems. On two sites with slopes 0% (flat) and 6% which are traditionally under winter cereals, Cynara cardunculus was sown adjacent to wheat in 2007. The crop is perennial, did not received any fertilization, irrigation or weed control and was used for moderate grazing activity ever since, offering a permanent soil cover throughout the years. In

summer 2024, a total of 60 soil samples (2 land uses × 2 slopes × 5 soil depth layers x 3 replicates) were collected, and full soil analyses (soil texture, pH, CaCO3, CEC, BS, EC, element concentration, etc.) were carried out including soil quality indicators (organic matter content, SOC, bulk density, soil structure, total N, P, K, infiltration parameters, water holding capacity, etc.). The results showed that annual monoculture has a strong negative effect on soil quality leading to soil degradation and desertification, while the use of perennial crops offering a permanent cover on the soil, resulted in a remarkable improvement in soil quality and soil rejuvenation. Therefore, introduction of low-input perennial crops is of paramount importance to mitigate further degradation and desertification in vulnerable Mediterranean agroecosystems.

10:05 *Katharina Pronkow*, *Josephine Bukowiecki*, *Nora Honsdorf* and *Henning Kage*

Crop Rotational Position Influences Soil Water Uptake and Canopy Temperature in Winter Wheat

PRESENTER: *Katharina Pronkow*

ABSTRACT. Wheat (Triticum aestivum) is one of the most important staple crops worldwide. But yield progress stagnated since the late 1990s. Possible reasons discussed are climate change, changes in agricultural policy or short crop rotations for wheat. Wheat grown in short rotations is known to be more susceptible to soil borne diseases and to decline in yield. This yield decline is more severe in years with drought stress conditions. Data were collected in three consecutive years (2020 – 2022) in a long-term field trial in Northern Germany. The data samplings were focused on the first (W1) and third (W3) year of wheat following OSR. The yield declined in W3. The Green Area Index (GAI) was monitored biweekly during the main growing season from beginning of April until end of July with spectral data taken with the UAV-based Parrot Sequoia camera. The W3 canopies developed a smaller GAI and showed faster senescence. Information about the canopy temperature were captured with thermal images by the drone with the DuetT camera by senseFly. The W3 canopies showed higher temperatures and the difference between W1 and W3 was highest in the unfertilized variants. The volumetric soil water content was measured weekly from April to July using the Sentek Diviner 2000 system. Higher changes in the soil water content over time for W1 were detected especially in deeper layers. Additionally at harvest the root health was rated visually on subsamples. The

rating showed higher destruction in the W3 variants. The results indicate the importance of an appropriate CRP to make plants more resilient to drought stress and to enable them to use more water from deeper soil layers.

10:25 Christos Vasilikiotis, Alice Chidiac, Iraklis Roulias, Sarah Meis, John Woodruff and Andreas Efstathiou

Integrating Multi-Species Cover Crops with Organic No-Till Practices for Enhanced Soil Health and Quality

PRESENTER: Christos Vasilikiotis

ABSTRACT. Sustainable agriculture emphasizes the integration of ecological principles to manage weeds, pests, and soil fertility. Traditional tillage, while effective for weed control, disrupts soil structure and depletes soil organic carbon (SOC), which is crucial for soil productivity and biodiversity. To address these issues, this study, evaluated the effects of cover crop mixtures and tillage practices on soil health and crop performance. Results indicate that cover crops, particularly those with higher legume ratios, improve soil organic matter, nutrient availability, and weed control, while no-till practices enhance water infiltration and moisture retention. These findings support the adoption of Regenerative Agriculture practices, such as cover cropping and no-tillage, for sustainable farming and long-term soil conservation.

10:45 Thomas Reitz, Lena Philipp, Alice Calvo, Fabiano Sillo, Luis Daniel Prada Salcedo, Vincenzo Montesano, Mauro Centritto and Raffaella Balestrini

Climate Change Impact on Agronomic Plant Parameters and the Associated Soil Microbiome in Agricultural Systems of Germany and Italy

PRESENTER: Thomas Reitz

ABSTRACT. In the context of global climate change, sustainable agricultural practices are essential for maintaining soil health and crop productivity. This study integrates findings from two separate field trials conducted in Germany and Italy, focusing on how different climatic and agricultural practices influence soil parameters, microbial communities, and crop performance. The combined insights help to elucidate the role of microbial dynamics in mitigating climate-induced stress and highlight potential strategies for soil restoration and improved resilience in agroecosystems. The first study, conducted at the Global Change Experimental Facility (GCEF) in Germany, evaluated soil health under

conventional and organic farming systems. Over the 2022 growing season, soil and rhizosphere samples were collected during key growth stages of spring barley: early growth, peak biomass, and mature growth. These samples were analyzed for nutrient availability, microbial activity, and the diversity of fungal and bacterial communities, as well as soil respiration and enzymatic activity. Notably, the experimental setup included a future climate scenario, with increased temperature and altered precipitation patterns to simulate conditions expected by 2070–2100. Comparing both management types, microbial biomass and respiration were found to be higher in conventionally farmed soils compared to organic soils. However, future climatic conditions did not significantly affect microbial biomass in either farming system. The study also revealed that while conventional farming resulted in higher overall microbial activity, enzyme activities-particularly those related to nutrient cycling-were negatively affected by future climate conditions, especially in conventional systems. These findings underline the importance of maintaining microbial health in the context of changing climatic conditions to ensure the continued functioning of agroecosystems. The second study, conducted in Italy, focused on the role of root-associated microorganisms, particularly arbuscular mycorrhizal fungi (AMF), in improving crop resilience to water stress in pepper (Capsicum annuum L.) cultivation. The research compared different irrigation regimes-well-watered, reduced irrigation, and rain-fed conditions-and examined the impact of AMF inoculation on plant physiology, biochemical stress markers, and microbial community dynamics. Reduced irrigation did not negatively impact plant stomatal conductance or overall crop performance, and AMF-inoculated plants exhibited enhanced tolerance to stress, as evidenced by lower oxidative stress markers and increased flavonoid content. Additionally, AMF colonization was most pronounced under reduced irrigation, suggesting that microbial symbiosis could enhance plant resilience to water-limited conditions. The shifts in microbial community composition across the irrigation treatments, alongside changes in enzymatic activity, highlighted the intricate relationship between plant-microbe interactions and crop stress response under climate change. The study suggests that optimizing irrigation practices while promoting beneficial microbial associations could improve crop productivity and resource use efficiency in drought-prone regions. Both studies provide critical insights into the role of microbial communities in enhancing soil health and crop resilience under changing climatic conditions. The GCEF research demonstrates the importance of microbial activity in maintaining soil health, while the Italian study highlights the potential of AMF inoculation to mitigate water stress and improve crop performance. Together, these findings emphasize the need for integrated approaches that combine sustainable land management practices, microbial interventions, and adaptive irrigation strategies to improve soil health and restore ecosystem functions in agricultural systems.

11:05-11:30 Coffee Break

11:30-13:30 Session S4: Soil Health Status and Restoration

CHAIRS: *Christos Vasilikiotis* and *Vasileios Tzanakakis*
LOCATION: Amphitheater Aristotle

11:30 *Konstantinos Zoukidis*, *Christos Vasilikiotis*, *Athanasios Gertsis*, *Antonio Scialletti*, *Georgios Strouthopoulos* and *Evangelos Vergos*

Effect of an organo-mineral fertilizer produced by recovered sulphur & orange wastes on winter wheat growth as a sustainable mitigation of soil desertification

PRESENTER: *Konstantinos Zoukidis*

ABSTRACT. European Environment Agency reports that 8% of the European territory (~14 million hectares) already shows some degrees of desertification. The uses of chemical fertilizers are causing substantial loss of soil fertility and especially in arid and semi-arid regions where desertification is a major problem. Intensive tillage and excessive fertilization practices affecting nutrient chemical properties, nutrient availability and cycle and crop productivity. In addition, aims of European Union’s (EU) Green Deal program are to reduce the reliance on agrochemicals and chemical fertilizers for a more sustainable agriculture, by utilization of organic fertilizers to preserve soil fertility. One European Commission’s goal is achieving a 30% reduction in non-renewable resource usage by recycling them into fertilizers (Marra et al., 2023). The reuse of organic waste materials for agricultural purposes (i.e. citrus waste) enhances soil quality by enriching soils with improving soil biodiversity, soil organic carbon and nutrients (Corti et al. 2012). Organic and industrial wastes can represent a great opportunity to produce organic-mineral fertilizers by using principles of circular economy with a great number of advantages for agriculture and environment (Muscolo et al., 2022). Sulphur is the fourth most critical plant nutrient after nitrogen, tends to be deficient

primarily in high-yield, arid, semiarid, and desertified soils (Yesmin et al. 2021). The fertilizer was tested for pathogens and heavy metals and the results evidenced absence of pathogens and heavy metals (Muscolo et al. 2021). The new fertilizer mix of Sulphur, Bentonite and Pastazzo (orange waste dried in powder), which improve the growth and the productivity of plants, is rich in sulphur, nitrogen, potassium, phosphorous and micronutrients, contains more carbohydrates simple and complex, amino acids, organic acids, increased microbial soil activity to produce enzymes that need to release nutrients and increase the soil fertility improving soil biodiversity and soil ecosystems. Main results and environmental benefits that expected at the end of the experiment was waste reduction, reduction of greenhouse gas (GHG) emissions, create a new organic-mineral fertilizers that can replace chemical fertilizers, improve soil properties and soil protection (decreasing soil pH, increase organic carbon, nitrogen, Cation Exchange Capacity (CEC), nutrients, microbial biomass, improving soil biodiversity and improving soil quality) and soil surface with desertification effect mitigated (Marra et al., 2023). The new fertilizer type aims to contribute to the following European environmental policies and legislations with a focus on soil and land degradation: EU Thematic Strategy for Soil Protection, European Green Deal and aligns with the missions of FAO and United Nations Sustainable Development Goals, on eradicating hunger through sustainable soil management. The objective of this study was to turn orange (citrus) waste and recovered sulphur into a high-quality innovative organo- mineral fertiliser and soil improving product (named as RegOrgFert), which can be used in alkaline and degraded lands to improve soil fertility and productivity. The research / experimental cultivation of durum wheat took place at Perrotis College, a division of American Farm School (AFS), Thessaloniki, Greece, on a field with an area of approximately 12 ha (~ 3 ha per treatment) (Fig. 1). The fertilization mixing of sulphur, bentonite and agricultural wastes (pastazzo) to obtain a new organic-mineral fertilizer was applied before seeding the durum wheat (variety Giulio at 250 kg/ha rate), and at the middle of vegetative cycle and will be compared to other fertilizers currently used in agriculture such as chemical fertilizer [winter fertilization (200 kg/ha) 16-20-0 + SO3 and spring fertilization (150 kg/ha) 40-0-0 + 14% SO3] and compost cow manure (20 m3/ha), and an unfertilized soil plot will be used as the control treatment. Fertilization with the new organic-mineral fertilizer ¨RegOrgFert¨ (476Kg/ha) will be twice per year (cultivation period 2022-2023 and 2023-2024). In the end of every year's cultivation period, measurements were conducted for field products parameters [yellow index or vitreous (kernels) (%), protein content, gluten index, total yield per treatment], soil parameters [soil texture, soil moisture (VWC%), soil electrical conductivity (dS/m), soil pH, CEC (meq/100g), total N, phosphorus and exchange K, C/N ratio] and evaluate total yield. Moreover, more analysis has been done, such as: agronomic traits [root, stem & seed head (fresh and dry weight, length) and number of tillers], analyze nutrient content in plant tissues and measuring soil respiration (CO2 flux). More specifically the study aims to compare the effectiveness of the new organic-mineral fertilizer (Sulfur-Bentonite-Pastazzo) on soils and crops with the soils treated with chemical fertilizers and composted cow manure. The results varied between the two years due to very low rainfall (about 40 % less) during the rowing season during the second year. Overall the results (Table 1) indicated that yield and other agronomic traits highly increased in the RegOrgFert fertilizer vs. Chemical fertilizer and the other treatments applied. The last year, the total yield and test field products and soil parameters were the best in the RegOrgFert treatment from all the others treatments (manure, chemical fertilizer and control). During these 2 years, soil pH decreased, and soil carbon (SOC) and soil Cation Exchange Capacity (CEC) increased and soil respiration [CO2 flux (μmol m^{-2} s^{-1})] was the maximum measurement. In conclusion, the use of the new mix RegOrgFert is proven on wheat production and recommended as a means to improve soil properties responsible for reducing desertification effects.

11:50 *Dimitrios Triantakonstantis*, *Maria Batsalia* and *Nikolaos Lolos*

Topsoil and subsoil distribution of soil properties in an agricultural area

PRESENTER: *Maria Batsalia*

ABSTRACT. Despite its importance for storing carbon, the subsoil is understudied. At the same time, legacy data are underutilized. Harmonization efforts are needed to ensure that they will remain useful for present and future. This work utilized legacy data from Karditsa area (Greece) and aimed to investigate subsoil organic matter, pH, CaCO3, cation exchange capacity (CEC), silt, clay and their relationship with vegetation (e.g. NDVI) and geomorphology (e.g. elevation and aspect). There were significant differences for most soil properties between depths. The highest correlations were found

between CEC and soil texture (silt and clay), while the other correlations were moderate to small.

12:10 Konstantinos Zoukidis, Athanasios Gertsis, Stefanos Stefanou, Vasileios-Marios Stathopoulos, Pavlos Prantzios, Georgios Strouthopoulos and Ramonna Kosheleva

Irrigation with high salinity water using innovative technologies (nanobubbles and an electronic water treatment system) to evaluate lettuce production grown in pots in greenhouse

PRESENTER: Konstantinos Zoukidis

ABSTRACT. A popular fresh vegetable, lettuce (Lactuca Sativa L.) is one of the world's most commonly consumed horticultural crops and is praised for its high nutritional content and antioxidants (Yang et al., 2022). Lettuce is commercially available all year and grown in open fields, greenhouses, or plant factories using vertical hydroponic systems using artificial light sources. Leafy vegetables often require a lot of water to grow and respond well to sufficient soil moisture at shallow root depths. One of the most critical factors to vegetable plant growth and yield is soil and water salinity. It is estimated that by 2050, half of all arable land (in the EU, especially the southern European Member States) will be affected by salinization, when water demand is expected to increase by up to 30% in the context of global warming. Any sustainable crop management coupled with technologies to reduce or mitigate salinity effects will contribute to improve ecological footprint and mitigate the climate effects. . The targets of European Green Deal include improving water and soil quality related issues due to the Zero Pollution Action Plan. Global installed capacity for the production of desalinated water has increased significantly in recent years, but due to high energy cost is used only to a limited extent in Europe (about 10% of global capacity). Many industries, including agriculture, have taken advantages of recent technological developments in nanotechnology and nanobubbles (NB) systems, because of their expanding importance and unique qualities (Liu et al., 2012). Over the past ten years, there has been a significant surge in research focused on bulk nanobubbles, which are ultrafine bubbles with a diameter smaller than 1 μm (1000 nm) as defined by ISO 20480-1:2017. This increase in research activity has been observed in both academia and industry (Azevedo et al., 2019). Thus, NB used in irrigation systems present a viable option for maximizing agricultural productivity. It also improves soil fertility and

nutrient availability in addition to improving plant physiological features (Zhou et al., 2022). The solubility of gases in saltwater solutions diminishes as the salt concentration increases, sometimes referred to as the "salting-out effect." Salt dissolving in water involves the separation of salt molecules into ions, which are then surrounded by water molecules in a process called “solvation”. Solvation reduces the attraction between gaseous molecules, causing the discharge of any surplus dissolved gas. It is important to recognize that dissolved gas transfer in the liquid can sometimes happen as a novel occurrence - nanobubbles (Agarwal, et al., 2022). An electronic water treatment system of saline water (MAXGROW) used in irrigating soils could additionally manage high saline irrigation water, improve the soil's chemical properties, increase fertilizer use efficiency and could be an environmentally friendly technology for soil and agricultural improvement under arid and desertified land conditions. The objective of this study was to evaluate irrigation with high salinity water (ECi= 12 dS/m) with the use of two innovative technologies, for growing lettuce in pots filled with four different soil textures. Two innovative and inexpensive technologies were used under high salinity irrigation water (ECi = 12 dS/m). The first one is the application of a nanobubbles system [NB (Agro-Nanobubbles): http://hal.teiemt.gr/] and the other is an electronic water treatment system, based on low frequency radiation waves (MAXGROW: https://maxgrow.tech/). The research was conducted in the greenhouse of Perrotis College/American Farm School Thessaloniki, Greece, in which two different lettuce varieties (Iceberg and Lollo Rossa) were grown in 10 pots of 15 litters volume (2 plants per pot/replication) in 4 different soils. More specifically the study aims to compare the growth of the plant and the root development for two different lettuce varieties (Iceberg and Lollo Rossa), which were grown in four different soils [clay loam soil (CL), sandy loam soil (SL), sandy clay loam soil (SCL) and clay soil (C)], under high salinity water. The main water treatments were: a. Control / regular tap water (ECi = 0,6 dS/m), b. saline water (ECi = 12 dS/m) treated with MAXGROW and c. saline water (ECi = 12 dS/m) treated with MAXGROW and enriched with NB. Various vegetable agronomic parameters, analyses of nutrient content in plant tissues, irrigation water and soil properties were monitored to evaluate total yield. The results shown in Table 1, indicated that a combination of the two innovative and inexpensive technologies was the best treatment used, as compared to using one device separately and provided almost equal final fresh yield with the regular water treatment. The results varied among the 4 soil types as expected, but the trend was similar toward the combined effect of the two devices acting together. In the end of the experiment many soil parameters (pH, E.C., soil moisture (VWC %), total C, total N, C/N ratio, nutrients), Sodium Adsorption Ratio (SAR) and agronomic traits (root weight and length, fresh green biomass length, NDVI, SPAD and Chlorophyll fluorescence emission) have been measured. Data will be presented orally in the conference, due to the limited space of the 2 pages paper. Therefore, the two innovative and inexpensive technologies could provide very efficient and sustainable and financially affordable tools to mitigate high salinity irrigation problems in crop production systems.

12:30 *Ioannis Zografakis*, *Konstantina Skalidi*, *Elena Stavridou*, *Despoina Pediaditaki*, *Symeon Papanikolaou*, *Georgios Papaioannou*, *Ioannis Spyridakis*, *Ioannis Chasourakis*, *Antonios Loulakis*, *Nikolaos Volakakis*, *Vasileios Tzanakakis* and *Emmanouil Kambourakis*

The effect of management system and agroecological zone on soil organic matter and microbial activity of olive orchards in Crete, Greece

PRESENTER: *Ioannis Zografakis*

ABSTRACT. Olive orchards are of high importance for the Mediterranean area, shaping the Mediterranean landscape and contributing to agricultural economy, nutrition and cultural heritage of the area. Intensive agricultural production has provided several benefits, such as food sufficiency, higher income to farmers and less hand-labour costs. On the other hand, has negatively impacted agroecosystems, causing erosion and degradation of soil properties. Organic farming may mitigate the negative effects of intensive cultivation in the environment by prohibiting synthetic chemicals inputs and applying agroecological practices. This study took place at the Messara basin, Crete, Greece. Six pairs of organic and conventional olive orchards surveyed in two agroecological zones (hilly and plain), in April 2021. In each orchard, 3 soil composite samples/ha, at 0-10cm depth, were obtained at the canopy projection of randomly assigned olive trees. Soil particle size distribution, water holding capacity (WHC), soil pH (soil slurry), organic matter (Walkley-Black), active carbon (permanganate oxidisable carbon, POXC) and Kjeldahl nitrogen (TKN) were determined. Biochemical properties such as net N mineralization rate (NMR), potential nitrification

rate (PNR) and enzyme activities of urease, dehydrogenase, glucosidase and N-acetyl-glucosaminidase (NAG), were determined by aerobic incubations under laboratory-controlled conditions. Soils in the area are characterised as clay and clay loams. The plain agroecological zone presented higher water holding capacity compared to the hilly zone but no differences were detected between management systems and agroecological zones regarding TKN, soil organic matter and POXC. Significantly higher, NMR in the plain zone, and PNR were found in conventional orchards probably due to the use of synthetic fertilisers. On the other hand, enzyme activity was significantly higher in organic than conventional orchards regarding urease, dehydrogenase and glucosidase, indicating higher heterotrophic activity, due to organic fertilisers application and soil management.

12:50 *Athanasios Gertsis*, *Evangelos Vergos*, *Konstantinos Zoukidis* and *Stefanos Stefanou*
Agronomic responses to biochar application rates of leafy vegetables grown in pots under greenhouse conditions filled with two soils and two inert hydroponic substrates
PRESENTER: *Athanasios Gertsis*

ABSTRACT. A major issue in soils globally is the reduction of soil organic carbon, which is also related to the climate crisis. Applying biochar to soils and other growth media in hydroponic systems, is a hypothesized strategy for improving crop yield and mitigating climate change, but how various biochar types affect crop yield and the properties of soils and other growth media is still under investigation and long term studies are missing (Borchard et al., 2014). Biochar (BC) is carbonized by pyrolysis biomass that can be used as soil amendment. Positive effects on crop yield have been particularly pronounced when biochars have been applied to inherently poor or degraded soils especially in the tropics, and usually in combination with inorganic fertilizers (Biederman and Harpole, 2013). Schulz et al. (2013) demonstrated in greenhouse experiment with pure sand from a sand mine and a loamy topsoil from Germany that biochar additions could even synergistically increase the fertilization effect of compost on oats (Avena sativa). A recent study by Radhi et al., (2024) aimed to evaluate the impact of four biochar concentrations (0, 2, 5, and 8%) on single and interactive effects of salinity and drought stresses on the morphological, physiological, and photosynthetic parameters of faba bean plants. PCA analysis showed that plants displayed different behavior under non-stressed and stressed conditions. The most

discriminating quantitative characters were related to plant biomass production and photosynthesis, especially shoot dry mass, root dry mass, plant fresh mass, internal CO2 concentration, net CO2 assimilation rate, and relative water content. The obtained results confirm the biochar's important role in promoting plant growth under normal or stressed conditions. Thus, a better understanding of the impact of biochar on plant growth under drought and salinity stresses will be beneficial for sustainable agriculture. The presented study evaluated the effect of application for various rates of biochar produced by pyrolysis of organic materials (0%, 1%, 2%, 3%, 4% και 5% vol/vol) in 15 litter PVC pots experiments in the Greenhouse Lab of Perrotis College/American Farm School at Thessaloniki, Greece, with leafy vegetables. Four different growth media (GM) consisting of two soil textures (Loamy Sand and Clay Loam), pure coarse sand and agricultural texture perlite were used. Three cycles of leafy vegetables were evaluated, including three lettuce (Lactuca sativa L.) varieties type COS, Lollo Rosa and butterhead and endive (Cichorium endivia) var. Walone). Irrigation and a light fertilization were equally applied across all treatments, thourgh a drip irrigation system with a dripper per pot with 4 lph output). Measurements were taken for final fresh yield, SPAD units (Relative Leaf Chlorophyll Level), GM moisture and Soil Organic Carbon (SOC) at the end of all growth cycles. Partial results are reported in comprehensive Tables 1 and 2 for the GM and the BC rates (due to the limited space for this paper). Results have shown a mixed tendency across the GM and the different crop species used. In general, the application of BC did not increase, the yield of lettuce but no effects shown of endives but GM moisture in was almost linearly increased by increasing rates of BC.

13:10 *Alexandros Stefanakis*

A circular management model of waste sources reuse and recycling in the oil industry using nature-based solutions: case study in the Middle East

ABSTRACT. One of the main elements in the transition to a circular economy is to create and implement more sustainable management practices for raw materials, resources, and waste. Water is a fundamental and necessary resource for human survival and health and for the ecosystems, plays a central role in sustainable development and is a key shared resource throughout the supply chain. Nevertheless, in the current linear economic model this resource is

abstracted from natural sources (rivers, lakes, groundwater), consumed in households, industries, agriculture, etc., and finally 'returned' to the natural sources directly or after a treatment process. Although circular economy is already analysed and detailed by many governments and international organizations, the management of water resources and mainly wastewater (e.g., rainwater, urban runoff, sewage, industrial effluents) has not attracted a respective attention in the context of the circularity principles as it is the case for example for solid waste. In general, it can be said that wastewater (human waste, rainwater, runoff) remains the largest unutilized category of waste, which is, however, characterized as a pillar of circular economy by the European Commission. Treated wastewater can be recycled and reused multiple times. In a circular economy, it is viewed as a valuable resource, an approach of particular importance considering the increasing urban water pollution and the need for enhanced water security. A unique case study in the industry in Oman has to do with the management of oily produced water from oilfields (Stefanakis, 2020a), i.e., the water that is produced during the exploration and production of oil and gas. This water contains residual hydrocarbons and its management is still a challenge (Schaffer et al., 2013). In this facility, the green technology of constructed wetlands (CW) is implemented at a large scale as an effective, cost-efficient and ecological solution for the treatment of water polluted with petroleum hydrocarbons. The CW system started its operation in 2010 and today its treats 175,000 m^3/day (Stefanakis, 2020a). The climate in the area is a typical desert climate, with very high air temperatures (exceeding 50°C during summer months) and negligible precipitation. This CW consists in 490 hectares of free water surface CWs and 780 hectares of evaporation ponds. The CW is a polyculture planted with various native wetland species to enhance the biomass production and the ecosystem biodiversity and resilience. Circularity is applied in this facility since the clean treated effluent is reused for irrigation. An irrigation field of 22 hectares includes various salt tolerant plants with market value such as biofuels, cotton, forage grass, among others. This irrigation project provided important information about the plant species that can survive under these environmental conditions (water quality, climate) and yield a beneficial product with a commercial value. Another trial focused on a hydroponic trial for fodder production. The materials cycles were further closed by onsite compost production; for this, a trial was carried out using the reed biomass as main substrate, resulting in a compost that could be used in the adjacent irrigation field. Based on the same approach, the use of the reed biomass for biogas production was also tested to cover the minimum energy demand of the facility. This abstract will present an overview of this circular management model for the various waste streams produced in the oil industry that was applied at the largest scale in the Middle East.

13:30-14:00 Session PS: Poster Session

LOCATION: Amphitheater Aristotle

13:30 *Antonios Apostolakis*, *Nikolaos P. Nikolaidis* and *Nikolaos V. Paranychianakis*

Gradual recovery of soil structure and organic carbon stocks in semi-arid fine-textured soils after setting aside arable land

PRESENTER: *Antonios Apostolakis*

ABSTRACT. In arable agricultural land, soil tillage disturbs the process of soil aggregation, deteriorating soil structure and depleting soil organic matter (SOM), both critical for robust and productive agroecosystems. Identifying management practices that protect or recover soil structure and SOM is crucial for sustainable agriculture. This is even more critical in (semi-)arid regions where agricultural soils are characterized by low organic carbon (OC) and hence are vulnerable to fertility loss. The set-aside practice, traditionally applied in the Mediterranean region, aims to restore soil fertility from intensive cultivation. However, the efficacy of set-aside in recovering soil structure and SOM in (semi-)arid agroecosystems, as well as the timescales required to reach sufficient or optimal soil fertility levels, remain unclear. We studied soil structure and SOM dynamics in three adjacent fields in Heraklion, Crete, subjected to set-aside for different periods of time. The region has a (semi-)arid climate with mean annual precipitation of 654 mm, mean annual temperature of 17.3°C and an elevation of 600 m above sea level. The soils are fine textured with 53% clay and 36% silt and a pH of 8.1. Until the early 1960s, the three fields of our study were a single field planted with arable crops (cereals) tilled once per year. In 1964, the field was planted with vines tilled twice per year, while a part was converted to set-aside. In 2008, another part of the field was also converted to set-aside. The three fields of our study are characterized by a uniform topography and are of similar size. As the fields represented real-world agroecosystems and not an experimental field-trial, they did not follow a randomized and replication design. In Spring 2014, soil samples were collected at 0-15 cm

depth with a spade and were representative of each field. To account for the variability in soil properties, we sampled pseudo-replicates from each field. Soil samples were sieved at 4 mm, air-dried for 48 hours and kept at a cool place until further analysis. We isolated soil aggregates of five size classes (i.e., <53 μm, 53-250 μm, 250-1000 μm, 1000-2000 μm and >2000 μm) with the wet sieving method. We determined the OC content and nitrogen content in each aggregate size class as well as in the bulk soil. In the bulk soil samples, we determined soil texture with the hydrometer method. At the time of sampling, we also collected soil samples with Kopecky rings for the determination of bulk density. To estimate the time needed for soil structure and soil organic matter recovery under the set-aside practice, we used the Carbon, Aggregation and Structure Turnover (CAST) model. The CAST model considers three aggregate classes (i.e., silt-clay sized aggregates: <53 μm, micro-aggregates: 53-250 μm, macro-aggregates: >250 μm), and for each (size-appropriate) class considers the carbon pools described in the RothC model (i.e., fine and coarse decomposable and resistant plant material, microbial biomass, humified organic matter and inert organic matter). We calibrated the CAST model with data collected from the set-aside fields adopting the space-for-time substitution assumption. The field under set-aside for 50 years had a macro-aggregate mass of 71±2%, followed by the field under six-year set-aside (macro-aggregate mass of 54±5%) and the field of continuous cultivation (macro-aggregate mass of 34±5%). A stable soil structure is indicated by a water-stable macro-aggregate mass of >60% (Banwart et al., 2011), which was not met even after six years of set-aside. Soil organic carbon stocks were 37.9±1.2, 29.4±4.6 and 28.8±2.5 t C ha-1 for the 50, six and zero-year set-aside fields, respectively. A fertility threshold of 64 t C ha-1 (estimated considering an OC to fine mineral particles ratio of 4.5 after Giannakis et al., 2014) was not met even after 50 years of set-aside. Running the CAST model for the conditions of our fields, we predicted that soil structure could reach fertility thresholds within seven simulation years of set-aside practice. In addition, we estimated that soil carbon accumulation rates would decrease significantly after the first 20 years of set-aside (i.e., from 0.34 t C ha-1 yr-1 for the first 20 years, to less than 0.10 t C ha-1 yr-1 thereafter). Based on our projection, soil organic carbon stocks will not reach expected fertility thresholds (i.e., >64 t C ha-1) even after 200 simulation years. Set-aside alone cannot restore soil structure and SOM in timescales relevant for agricultural management in semi-arid agroecosystems and additional restoration measures are needed.

13:33 *Manolis Grillakis*, *Athanasios Tsilimigkras* and *Aristeidis Koutroulis*

Climate change impacts on the rainfall erosivity for the Mediterranean

ABSTRACT. Soil and rainfall interactions play a crucial role in land's ecological, hydrological, and biogeochemical cycles. Among those interactions, rainfall-induced soil erosion impacts soil functions by changing soil structure and its composition, affecting the soil's ability to retain moisture and nutrients and overall, it's fertility. In this study we assess the effect of the past anthropogenically imposed climate change on the rainfall erosivity in the Mediterranean region. To attribute changes in the rainfall erosivity to the anthropogenic climate change, we analyze precipitation data that describe the actual past climate over the last ~120 years, as well as a hypothetical climate scenario that would have occurred without any anthropogenic influence on climate. To achieve this goal, we combine the use of established methods to estimate the rainfall erosivity at a daily and sub daily time scales, as well as stablished datasets. Our results show contrasting patterns of change across the Mediterranean region. The influence of climate change on rainfall erosivity is shown to be mostly positive in sign across the South and Eastern Mediterranean regions, while it is simulated as negative in large parts of northern Balkans, Italy, France and parts of Spain, with high spatial variability on the intensity of those changes.

This work has received funding from REACT4MED: Inclusive Outscaling of Agro-Ecosystem Restoration Actions for the Mediterranean. The REACT4MED Project (grant agreement 2122) is funded by PRIMA, a program supported by Horizon 2020.

13:36 *Nikolaos Paranychianakis*, *Maria Frantzeskou*, *Safiye Tul* and *Nefeli Milaiou*

Response of soil microbial communities to olive mill wastewater application

PRESENTER: *Nikolaos Paranychianakis*

ABSTRACT. Olive mill wastewater (OMW) has been linked with severe environmental impacts and its management remains a challenge in olive oil-producing countries. In recent years, emphasis has been given to land application of OMW since this management practice is consistent with the concept of circular economy, characterized by low operation costs, and due to the advantages of

this practice, like the low operation costs and nutrient recycling in agriculture (Vaz et al., 2024). Although currently application of OMW to the soil has been regulated in several Mediterranean countries, the allowed application rates remain low to prevent any toxic effects to crops and soils. Yet our knowledge on the effects of OMW application to soil microbial communities and soil functioning remain limited. Early work has identified potentially adverse effects on N cycling an effect attributed to N immobilization (Tsiknia et al., 2023). The main objective of this study is to investigate the short-term effects of OMW application on the soil microbial communities and on the processes regulating C and N cycling. Specifically, we monitored respiration rate, nitrification rate and soil microbiome evolution to optimize OMW management and to maximize benefits to soils and crops. The study was performed under controlled conditions in pots of 0.5 l volume were filled in with 500 g of dry soil, previously passed through a 2-mm sieve. Four treatments were applied 0, 4.2, 8.4, and 16.8 mm of OMW that corresponded to 0, 42, 84, and 168 m3/ha, respectively. Soil was collected from the pots at Day 3, Day 15, and Day 50 and DNA was extracted using the PowerSoil® Total DNA Kit (Qiagen GmbH). The universal prokaryotic primer pair 515f/806r was used to amplify the V4 hypervariable region of the 16S rRNA gene, which was subsequently sequenced in a MiSeq Illumina platform at the NOVOGENE UK Facilities. Raw reads were processed with the DADA2 (v. 1.22) pipeline following the typical workflow. α-diversity (Shannon index), β-diversity (Bray–Curtis dissimilarity), composition and differential analysis were employed to understand the effects of the applied management scenarios. All bioinformatic and statistical analyses were performed in the R environment using the packages phyloseq, microbiome, microeco, vegan, ade, microeco and Deseq2. Sequence analysis showed strong effects of OMW on soil microbial communities and these effects were dependent on application rates. Specifically, α-diversity decreased significantly with increasing OMW application rate and these effects remained significant 50 days following OMW application. Similarly, OMW imposed strong effects on β-diversity with the microbial communities to form distinct clusters separated by OMW application rate and time elapsed since application. In accordance, OMW resulted in significant shifts in microbial community composition. Proteobacteria responded positively to OMW application rate, while the relative abundance Chloroflexi, Planctomycetes, Acidobacteria, Gemmatimonadota decreased. Despite the strong effects of OMW on soil microbiota, respiration rates did not reveal any evidence of toxic or inhibitory effects on soil respiration and responded positively to application rate. By contrast nitrification rate remained low at all treatments and the higher microbial biomass in OMW treated soils provides further support for OMW-stimulated N immobilization. Our findings indicate that OMW application steers soil microbial communities and these effects are long lasting and thus application rates must not exceed 50% of soil water holding capacity.

13:39 *Nikolaos Paranychianakis* and *Maria Frantzeskou*

Strong compositional shifts in leaf microbiome precede the development of leaf abscission zone and form litter decomposing communities

ABSTRACT. Leaves comprise of a significant source of litter input in soils where it decomposes releasing nutrients and forming soil organic matter (SOM). The traditional view assumes that following leaf fall, microorganisms thriving in the soil inoculate the leaves initiating their decomposition. This approach has been challenged, however, in recent years following the study of the leaf microbiome. An increasing number of studies have provided support that leaf microbiome is assembled by selective pressures and exert strong effects on crop performance. The phyllosphere microbiome is dynamic and shows compositional shifts during crop developmental stages and in response to environmental factors (Almario et al. 2022). Few studies, however, have focused on the late stages of leaf development, like the initiation of senescence, formation of the abscission zone, and leaf fall (Voříšková and Baldrian 2013, Veen et al. 2019). Likely, leaf microbiome during the late stages of development has an important role in the decomposition and has been linked to home field advantage (Fanin et al. 2021). It can be hypothesized, thus, that the formation of abscission zone represents a tipping point in the composition and functioning of leaf microbiome that is a re-organization of the microbiome from a community specific to support leaf, and plant, function to the assembly of litter decomposing communities. Therefore, leaves may arrive in the soil with well-formed decomposing communities that contrasts the common belief that soil is the main source of decomposing microorganisms. If this assumption holds, then soil microorganisms are expected to have a weaker role in liter decomposition while priority effects will set up additional barriers. Leaves of different developmental stages (growing leaves, fully

developed leaves, leaves start aging, aged (yellow) leaves (formed abscission zone), recently fallen leaves (2-3 days), leaves fallen for long period > 1 month) were sampled from olive trees (May 2023) and Prunus cerasus (September 2022). Leaf epiphytic microbial communities were isolated using common protocols and DNA was extracted with the PowerSoil® Total DNA Kit (Qiagen GmbH). The V4 and ITS2 regions of bacteria and fungi were amplified and sequenced in a MiSeq Illumina platform at the NOVOGENE UK Facilities. Raw reads were processed with the DADA2 (v. 1.22) pipeline following the typical workflow. Different metrics were used to estimate the α-diversity of microbial communities (Shannon, Pielou's J, Faith's PD) and β-diversity (Bray–Curtis dissimilarity, UniFrac distances). All the bioinformatic and statistical analyses were performed in the R environment using the packages phyloseq, microbiome, microeco, vegan, ade, microeco and iCamp and Deseq2. Our findings indicate strong compositional shifts during leaf aging in both species but also plant species dependent effects. Microbial communities in the leaves from of P cerasus confirm our hypothesis for prevalence of stochastic processes in the assembly of microbial communities before the formation of leaf abscission zone. However, this response is not confirmed in the evergreen olive trees indicating differences among deciduous and evergreen plant species. Collectively, our findings provided evidence that leaf decomposition initiates before the leaf fall and phyllosphere is the major source of decomposers challenging the widely accepted assumption of soil microbiota. Our findings also outline the need for major updates in the existing modelling frameworks and particularly on next generation biogeochemical models that explicitly consider microbiota in the biogeochemical cycle of C.

13:42 *Nikolaos Paranychianakis*, *Safiye Tul*, *Maria Frantzeskou* and *Thomas Reitz*

Soil microbial communities respond slowly to soil conservation practices in the Mediterranean region

ABSTRACT. Soil microbial communities play a dominant role in the functioning of soils and the ecosystem services derived from them. Still, we lack a thorough understanding of the drivers shaping the soil microbiome. It is likely to be an interplay of several factors including soil properties, biotic factors, climate, and management practices (Philippot et al., 2024). Tillage, for instance, disrupts soil microbial

communities, particularly by negatively affecting soil fungi, altering composition, diversity, network stability and functioning of microbial communities. By contrast, no-tillage can promote microbial community diversity and functioning through soil aggregate formation (Hartmann and Six, 2023). However, mixed effects have been reported in the literature that may arise from differences in environmental conditions or the time elapsed since the initiation of the conservation practices. In this work, focusing on olive orchards, we hypothesize that the positive effects of soil conservation practices on microbiota: i) would increase over time and/or with the amount of organic matter inputs to the soil. Further we assumed that ii) these effects would be more evident during the winter and spring when temperature and soil moisture do not impose strong selection filters to microbial communities. To test our hypotheses, seasonal samplings (winter, spring, summer, autumn) were performed in four experimental olive orchards at the island of Crete to investigate the effect of soil conservation practices on soil microbiome. The conservation practices included tillage vs no-tillage without (Field 1 and Field 2) or with pruning's incorporation and legume intercropping (Field 3) and biochar addition (Field 4). Soil was collected from 0-15 cm depth and DNA was extracted using the PowerSoil® Total DNA Kit (Qiagen GmbH). The universal prokaryotic primer pair 515f/806r was used to amplify the V4 hypervariable region of the 16S rRNA gene, which was subsequently sequenced in a MiSeq Illumina platform at the NOVOGENE UK Facilities. Raw reads were processed with the DADA2 (v. 1.22) pipeline following the typical workflow. α-diversity (Shannon index), β-diversity (Bray–Curtis dissimilarity), composition and differential analysis were employed to understand the effects of the applied management scenarios. All bioinformatic and statistical analyses were performed in the R environment using the packages phyloseq, microbiome, microeco, vegan, ade, microeco and Deseq2. Sequence analysis revealed that location had a greater effect on soil microbial communities than the applied conservation practices, likely due to legacy effects of environmental factors and soil properties on soil microbial communities' assembly. Soil conservation practices had minor effects on α- and β-diversity even at sites that combined more than one conservation practice (e.g., pruning incorporation and legume intercropping) after one decade since their initiation. Our findings support the second hypothesis that differences in α-diversity are more pronounced during the winter. Differential analysis revealed only few taxa that responded differentially, while no management effects were found for soil enzymes activity. We also observed a shift in microbial communities composition towards more thermotolerant and stress-adapted taxa, e.g., Archaea, Nitrososphaeraceae, in the summer and autumn of the 3rd growing season with potentially detrimental effects on soil functioning. These findings are in accordance with previous work showing that extreme climatic events, as those occurred during the 2023 growing season in our experimental fields, impose strong effects on soil microbiota. In conclusion, our findings reveal that soil microbiota responds slowly to conservation practices and that environmental parameters can override their effect on soil microbiota in the Mediterranean landscapes challenging the effectiveness of commonly applied soil conservation practices to maintain/restore soil functioning under future climatic conditions

13:45 *Safiye Tul*, *Maria Frantzeskou* and *Nikolaos Paranychianakis*

Climate-driven variability in soil Enzyme dynamics: Unveiling temperature sensitivity of phosphatase and β-glucosidase activity

PRESENTER: *Safiye Tul*

ABSTRACT. Soil enzymes play a critical role in the functioning of agroecosystems by regulating nutrients biogeochemical cycles through their effects on nutrient availability and SOM content (Feng et al., 2023). Understanding the response of enzymes to global warming is important for developing appropriate management practices that maintain/restore soil health as well as the simulations provided by soil biogeochemical models. While extracellular enzyme activities (EEA) are known to be sensitive to temperature, their responses to highly fluctuating temperatures temporarily and spatially in semi-arid landscapes remain yet poorly understood. For instance, temperature in orchards shows great variations locally (canopy vs. in rows) which in turn may affect enzymes activity. To address this knowledge gap, this study aimed to evaluate the activities of representative enzymes involved in C and phosphorus cycling in a range of temperature (psychrophilic, mesophilic, thermophilic). We hypothesized that EEA, and their temperature sensitivity (Q10), are influenced by sampling location and pre-incubation temperature due to thermal adaptation of soil microbial community. Based on Michaelis Menten kinetics, we also hypothesized that enzyme affinity to substrate (Km) is more sensitive to warming in microbial

communities pre-incubated at lower temperatures.

To test our hypothesis, we measured potential EEA and Q10 at six assay temperatures (4, 15, 25, 35, 45, 55°C) after pre-incubating soil samples, adjusted to initial field moisture, for two weeks at 10, 25, or 45°C temperatures representative of the psychrophiles, mesophiles and thermophiles. Soil samples were collected from beneath the canopy and in the rows of an olive orchard in Crete, Greece, in July 2024 where temperature differs up to 10 oC during the summer period. Enzyme activities were measured fluorometrically using a DeNovix QFX fluorometer (excitation at 360 nm, emission at 465 nm) following the method of Breitkreutz et al. (2021). Q10 values were calculated using the equation Q10 = exp (slope × 10) from the slope of enzyme activity across assay temperatures. Statistical analysis was conducted in the R software using three-way ANOVA to assess the effect of pre-incubation temperature, assay temperature, and location on EEA. Data were log-transformed as necessary, and linear model assumptions were validated with diagnostic plots. Significant differences ($p < 0.05$) were tested using Tukey's HSD test.

Enzyme activity was significantly higher beneath the canopy compared to rows for phosphatase and β-glucosidase (Figure 1). Samples pre-incubated at 10°C showed significantly higher enzyme activity than those at 25°C and 45°C. Assay incubation temperatures of 25°C, 35°C, 45°C, and 55°C resulted in significantly higher activity of phosphatase and β-glucosidase compared to 4°C and 15°C, with 55°C showing the highest phosphatase activity. Significant interactions were observed between sample location and pre-incubation temperatures for phosphatase and between location and assay temperatures for β-glucosidase. The increase in enzyme activity with rising assay temperatures aligns with previous research (Steinweg et al., 2013; 2007; German et al., 2012). Higher activities under the canopy are likely due to better organic matter input, moisture retention, and stable microclimatic conditions, promoting microbial activity and nutrient cycling. The low pre-incubation temperatures (10°C) appeared to preserve enzyme stability and activity. This is consistent with Michaelis-Menten kinetics, which suggests that as temperatures rise from cold conditions, Km may increase, indicating reduced substrate affinity, but at higher temperatures, further warming may not affect Km, providing support for thermal adaptation of the enzymes (Rogers and Gibon, 2009).

Both β-glucosidase and phosphatase activities showed low temperature sensitivity between 5°C and 15°C. However, thermal sensitivity increased in the range of 25°C and 35°C. Q10 values remained relatively stable at higher temperatures, indicating that organic-C depolymerization is more severely affected by temperature changes (Figure 2; Adekanmbi et al., 2023). Additionally, for samples beneath the canopy pre-incubated at 10°C, both phosphatase and β-glucosidase increased at an assay temperature up to 55°C. This indicate that temperature may not be the rate limiting step in organic-C decomposition due to its increased sensitivity to temperature. The "Rows" generally show more pronounced peaks in Q10 values, indicating that the enzyme activities might be more temperature-sensitive in these areas compared to the "Canopy" locations due to less favorable conditions, unstable moisture. The observed sensitivity in Rows, in particular, could mean that these areas are more vulnerable to extreme temperature events, necessitating targeted management strategies to mitigate potential negative impacts on soil health.

13:48 Nektarios Kavroulakis, Myrto Tsiknia, Maria Kissandraki, Constantinos Chrysikopoulos and Anastasios Malandrakis

Assessing the Ecotoxicological Impact of Metallic Nanoparticles on Soil Microbial Community Structures

PRESENTER: Anastasios Malandrakis

ABSTRACT. The growing interest in sustainable agricultural practices has led to the exploration of innovative solutions that minimize the reliance on traditional agrochemicals. Among these, metallic nanoparticles (NPs) have emerged as promising agents, offering potential benefits as precise fertilizers and fungicides. Their application in soil not only aims to enhance crop yields but also to provide protection against plant pathogens, thereby fostering a more sustainable approach to agriculture. This study focuses on the effects of various metallic nanoparticles—specifically copper, silver, copper oxide, and zinc oxide—on soil microbial communities, which play a crucial role in maintaining soil health and fertility. By conducting a pot experiment with tomato plants under controlled conditions, we compared the influence of these nanoparticles against their bulk counterparts. Utilizing high-throughput sequencing of PCR-amplified 16S rRNA and ITS2 marker genes, we analyzed the structural and compositional changes in bacterial and fungal rhizospheric communities. Our findings reveal significant metal-dependent variations in microbial community structures, highlighting the

distinct impacts of different formulations. Notably, bulk formulations demonstrated a stronger effect on altering rhizospheric microbiomes than their nanoparticle counterparts, particularly affecting fungal communities. Silver-containing treatments, in particular, were found to induce pronounced changes in both bacterial and fungal populations, underscoring the complex interactions between metallic nanoparticles and soil microbiota. This research contributes valuable insights into the environmental implications of using metallic nanoparticles in agriculture and their potential role in promoting sustainable farming practices.

13:51 *Ioanna Manolikaki*, *Georgios Koubouris*, *Dimitrios Voloudakis*, *Ioannis Kapsomenakis*, *Themistoklis Koutsouras*, *George Koutras*, *Anna Vlachou* and *Georgios Motakis*

Digital Tools And Early Warning System For The Adaptation Of Olive Production To Climate Change - Olivealarm

PRESENTER: *Georgios Koubouris*

ABSTRACT. Abiotic and biotic stresses and mainly water scarcity, extreme temperature, olive fruit fly, and peacock spot have been major problems in recent years for olive cultivation due to climate change. The first objective of the OLIVEALARM project is to reduce the negative consequences of climate change through an early warning system for abiotic and biotic stresses. The early warning system is based on the development of agroclimatic indicators and correlation algorithms. The second objective synergistically with the first objective is to reduce inputs, protect the environment, and reduce production costs through the application of cultivation practices that improve the reduction of carbon and water footprints. Cultivation practices include the addition of organic materials to increase soil organic matter content, the use of products with biostimulants to enhance tree resilience, the cultivation of aromatic-pollinating plants to attract beneficial insects, and irrigation based on soil moisture sensors to optimize water use efficiency in two orchards in the areas of Laconia and Chania. OLIVEALARM project taking into account the soil and climatic conditions formulates a holistic approach to enhance the adaptation of olive cultivation to climate change with new digital technologies. The work was carried out in the context of the Project entitled: "Digital tools and early warning system for the adaptation of olive production to the Climate Change" -OLIVEALARM (M16ΣYN2-00205) for Action 2 of Submeasure 16.1-16.5 and is co-financed by the European Union and national

resources through the Rural Development Program (RDP) 2014 – 2020.

13:54 *Andreas Angelakis* and *Vasileios Tzanakakis*

Evolution of Water and Health in Greece

PRESENTER: *Vasileios Tzanakakis*

ABSTRACT. In general contaminated water and poor sanitation are associated with disease transmission directly or through the soil water. Absent, inadequate, or improperly managed water and soil resources and sanitation systems expose individuals to preventable health risks. Billions of people lack access to these basic services today and will remain in this condition for decades to come. Looking back at the history of water, soil, sanitation, and hygiene can help us understand the challenges and opportunities of these issues and draw lessons to achieve sustainable development in the future. In addition, many irrigation schemes of all sizes have had significant and largely adverse effects on human health through the creation of new vector habitats and the increase of man-vector-pathogen contact. For this purpose, proper measures can be taken to manipulate the physical environment. In such a way that these adverse health effects are minimized.

13:57 *Ioannis Kasapakis*, *Androniki Papafilippaki*, *Andreas Mavredakis*, *Nikolaos Paranychianakis* and *Konstantinos Chartzoulakis*

Agricultural soil health assessment with DSS combining open data and crop management information.

PRESENTER: *Ioannis Kasapakis*

ABSTRACT. Agriculture is usually associated with the predatory exploitation of land resources and the degradation of soil quality. Soil health can protect and improve its quality and reduce the impact of its exploitation. Agricultural soils health depends on factors that the farmer can influence and on others that he cannot influence. Data analytics of these factors from a DSS empowers farmers to estimate and manage soil health effectively and guide them to improve it. The farm level data which cannot be influenced by the farmer mainly concern the topography, the location, and the climatic elements of the area. Those data are usually available from open data sources. In any case, especially for the climate, long time series of elements from satellite data are examined, but as a priority, data from ground level sensors are examined, which solve the problem of low spatial resolution. Open data from ground sensors are leveraged for validation to analyze remote earth sensing data for the study

areas and crops. Smartphones through their embedded location and camera sensors and additionally thermal imaging sensors can provide real-time ground data to the decision support system. The data from cultivation techniques and cultivation operations and visual observations of the farmer should be entered by the farmer himself through mobile application in DSS. Farmer is guided by the application for the required observations and tests results in order to enter them into the DSS through the application. The DSS outputs concern the main soil health indicators the score in terms of these indicators and recommendations mainly about cultivation techniques to improve this score specifically for olive wheat and canola crops in the regions of Greece Tunisia and Italy. The farmer can use the app to examine the level of soil health under different climate change scenarios for his region and crop or examine year-to-year reports of hot summers and harsh winters.

14:00-15:00 Lunch Break

Méditerranée Restaurant

15:00-17:00 Session S5: Soil Microbiota and functioning: Response to management practices and environmental factors

CHAIRS: *Thomas Reitz* and *Myrto Tsiknia*

LOCATION: Amphitheater Aristotle

15:00 *Lena Philipp*, *Mengqi Wu*, *Evgenia Blagodatskaya* and *Thomas Reitz*

Soil Microbial Communities in Croplands and Grasslands: The Role of Depth and Climate Variability

PRESENTER: *Lena Philipp*

ABSTRACT. In addition to abiotic indicators, microbial parameters have become crucial indicators of soil health. Soil microorganisms are essential for nutrient cycling and pathogen prevention, making their abundance, as well as structural and functional diversity, to key factors in evaluating soil health. Climate change and intensified land use are major threats to biodiversity leading to soil degradation and loss of microbial diversity. There is still a considerable gap in our understanding of how these stressors specifically affect soil microbial communities. Moreover, microorganisms in deeper soil layers are dramatically understudied, as the average sampling depth in soil biology is 18 cm , and a considerable proportion of microbial biomass as well as carbon stocks lies within deeper soil. Thus, understanding how these factors impact the abundance and diversity of soil

microorganisms also in deeper soil layers is vital for assessing soil health in future scenarios. We investigated the single and interacting effects of land use and climate change on soil functioning using the Global Change Experimental Facility (GCEF) in Bad Lauchstädt, Germany. In this field experiment, two croplands (conventional and organic farming), and three grasslands (intensive meadow, extensive meadow and extensive pasture) are exposed to ambient vs. a predicted future climate with increased mean temperature and changed precipitation pattern. We collected soil samples from three depth layers (0-15 cm, 15-30 cm, 30-50 cm) in May 2022 and 2023 and determined abiotic soil properties (pH and C, N, P, K content), microbial biomass, root biomass and root length density. Microbial community structure was analyzed through amplicon sequencing (16S, ITS). Respiration and enzymatic activities of different elemental cycles served as microbial activity indices. We found strong land use effects on nearly all recorded parameters in all sampled depths, while climate effects were overall less prominent and mostly apparent within the uppermost soil layer. Additionally, some of the observed land use patterns for especially total carbon, microbial biomass and enzyme activities from the uppermost soil layer were reversed in deeper soil. While microbial biomass carbon in croplands was lower in the uppermost soil layer, that pattern changed in soil depths 15-30 cm and 30-50 cm, with higher microbial carbon in croplands compared to grasslands. Therefore, over the complete topsoil layer, land use differences disappeared highlighting the important role of the deeper soil layers. Neglecting deeper topsoil layers would e.g., underestimate microbial abundance and activity in croplands especially. While 2022 was an extremely dry year, and 2023 experienced a more wet spring, we found that in 2023 many of the microbial activity parameters (e.g. cellulase activity) were lower in the uppermost soil layer especially in grasslands, but higher in the deeper soil layers. This points towards a drought induced shift of microbial abundance and activity to deeper soil layers possibly related to more root exploration in the deeper soil layers as a drought response. Future research dealing with global change impacts on soil functionality should consider the complete topsoil layer, in order to understand the interconnected processes within the entire topsoil profile and to develop sustainable soil management practices that enhance overall soil functionality without compromising its resilience.

15:20

Ana Alexandre, *Joana Amaro Ribeiro*, *Francisca Morais* and *Isabel Brito*

Impact of cover crops on tomato rhizospheric microbiome

PRESENTER: *Ana Alexandre*

ABSTRACT. The use of cover crops, particularly on systems where the cash crop is grown on a specified season, has been shown to have multiple benefits on the context of agricultural production, such as enhancing soil structure and improving soil physical and chemical properties (Hao et al. 2023). Although the benefits of cover crops on different aspects contributing to soil health are well documented, our knowledge on the impact of cover crops on the microbial communities colonizing the following crop is still scarce. Tomato is a spring/summer crop and in the traditional production system for industry tomato, the soil is left uncovered until the spring operations prior to planting. The present study evaluated the impacts of different winter cover crops on the bacterial community assembly of the tomato rhizosphere. The winter cover crop on the tomato production system was implemented with the adaptation of some of the traditional cultural practices, namely the anticipation of the soil decompaction operations and earlier ridges preparation, the installation of a cover crop over winter and spring planting of tomato with minimal soil mobilisation. Four treatments were performed under field conditions (Pancas, Portugal): oat as cover crop, a mixture of oat and rapeseed as cover crop, natural vegetation cover (no cover crop was sown) and control (traditional land preparation and no cover crop). A total of 4 rhizospheric soil samples were collected from each treatment replicate (two field replicates per treatment were performed, with the exception of the control, which had a single plot). Total soil DNA was extracted (Qiagen Power Soil kit) and the 16S rRNA amplicon metagenomics was performed using the V5-V7 region (Novogene). The analysis of the bacterial communities of the cover crops showed that oat and rapeseed rhizosphere harbour different bacterial communities and that the presence of the rapeseed on the mixed cover crop (oat+rapeseed) influenced the bacterial population found on the oat rhizosphere. Although tomato plants assemble a distinct rhizospheric bacterial community from that of oat or rapeseed, our results showed that the bacterial community of the tomato was influenced by the preceding cover crop. In addition, the bacterial community found in tomato after natural vegetation cover and no cover crop treatment was similar. The present results indicate that the cover crop may be used

as a tool to shape the microbiome of the latter crop and this envisions the potential role of cover crop management in the cash crop protection from biotic or abiotic stresses.

15:40 Georgios Leventis, Dimitra Stathopoulou, Martha Apostolidou, Georgios Petrakis, Myrto Tsiknia and Constantinos Ehaliotis

Indigenous and plant specific microbial community consortia derived from phryganic biomes improve plant fitness and soil functions in ecosystem restoration of quarry deposits in Milos (Greece)

PRESENTER: Georgios Leventis

ABSTRACT. Quarrying operations cause irreversible damage to the local environment creating vast degradation problems including fertile soil depletion, vegetation removal, and alterations in the original topography. Restoration practitioners aim to restore ecosystem functions by re-installing plants, focusing on recreating specific plant communities based on historical, reference, or desirable output. However, routine restoration interventions often overlook the importance of soil microbial communities and plant-microbe interactions, and make poor use of microbiome-based tools. Although it is well-established that root-associated microbial communities play a pivotal role in plant-host performance & stress tolerance, support pioneer plant colonizers, and provide essential ecosystem services, such as disease suppression, pollutant remediation, nutrient cycling, water management, and carbon sequestration, their potential use in soil restoration and rehabilitation remains underexplored. In this study, we investigated the impact of whole soil community inocula on the growth and performance of three native drought tolerant plant species, along with their effects on soil fertility and soil functions. We propose that this promising microbiome-based approach may be further developed and serve as a sustainable, eco-friendly and cost-effective strategy for enhancing revegetation and soil restoration in barren quarry areas.

16:00 Savvas Paragkamian, Panagiotis Sarris, Evangelos Pafilis, Georgios Kotoulas and Christos Christakis

From microbes to ecosystems: towards a Crete island soil system

PRESENTER: Savvas Paragkamian

ABSTRACT. Ecosystem data integration aims at incorporating all available knowledge at the system level. This type of integration is a prerequisite to decipher ecosystem function.

Crete has been sampled for soil and biodiversity in many different ecosystems across the centuries leading to a wealth of available data. Here, an emphasis is given to the Island Sampling Day project topsoil microbiome data of the Genome Standards Consortium. More specifically, bacteria were assessed to identify signals of taxa in ecosystems that have health concerns.

These data are then coupled with open data about Crete island that fall in literature, samplings and maps categories. The literature analysis showed the huge catalogue of historical datasets are not still incorporated in open databases. Regarding maps, there are different aspects of the soil ecosystem. Climate, geology, elevation and slope, soil type, land cover type, land management are among the major variables of the terrestrial environments of Crete. In addition, Crete has been assessed for climate change and desertification in many studies adding more layers of information to the Crete soil system. All these data are further establishing Crete as a great soil model island.

16:20 *Maria Frantzeskou*, *Rafaila Nikola Mourgela*, *Evdokia Syranidou* and *Nikolaos Paranychianakis*
Contribution of thermotolerant bacteria on soil carbon cycle
PRESENTER: *Maria Frantzeskou*

ABSTRACT. The increase of temperature and the frequency of heatwave events caused by climate change will adversely affect ecosystems and their functioning. Soil surface temperatures (T) exceeding 45oC are already being reported, surpassing the optimal values of mesophilic microorganisms. These trends in temperature are especially alarming for arid or semi-arid regions, like the Mediterranean basin, with potentially adverse effects on agro-ecosystems and microbial diversity, induced by frequent heatwaves and already scarce water. Alterations in microbial community structure triggered by climate change could potentially affect the community's stability and resilience toward future climatic conditions (Jansson & Hofmockel, 2020), as well as the soil C stocks. Even though the prevalence of elevated soil T has been inexplicably linked with the presence of thermophilic/ thermotolerant bacteria, their role in the C biogeochemical cycle remains obscure. Existing biogeochemical models do not account for such shifts in the composition and metabolic potential of soil microbiota which in turn may result in biased predictions of the response of C

stocks to T increase. The evolutionary adaption of thermophilic and thermotolerant bacteria may favour higher overall activities than mesophiles under conditions of higher T. The effect of such shifts on soil health and C stocks, however, remains uncertain. To further understand the contribution of thermotolerant/thermophilic bacteria on the C cycling, we isolated thermophilic strains and evaluated them for plant growth-promoting (PGP) traits and soil functioning. Furthermore, we conducted preliminary microcosm experiments to monitor their GHG emissions in response to elevated temperature. Greenhouse soils were sampled and used to isolate and cultivate soil bacteria. The NucleoSpin® Microbial DNA kit was used for DNA extraction and for 16S DNA sequenced with the primer pair 27f and 1492r to identify their taxonomy. The bacteria were then tested and scored based on PGP traits (P solubilization, N fixation, and the production of ACC deaminase and IAA) and abiotic stress resilience. Abiotic tests were conducted to test their growth under high temperatures (40oC and 50oC) and salinity (agar with 5% and 10% NaCl). The growth rate of the bacteria with positive results at the high-temperature abiotic test (50oC) was then determined for a range of temperatures (10oC - 65oC), using lysogeny broth (LB). In addition to these thermotolerant bacteria, mesophilic strains were used as controls. The growth rate was calculated from experimental cultures' optical density (OD600), using the “Growthcurver” package in R. A preliminary microcosm experiment was conducted where monitoring of GHGs was performed for selected thermotolerant and mesophilic bacteria inoculated in soil and incubated at 45oC, using an FTIR gas analyser (GASMET 4015). The resulting concentrations were converted into gas fluxes using the “gasfluxes” package in R. The abiotic stress test revealed that all the thermotolerant strains were more resilient than the mesophiles. In addition, 90% of the selected thermophilic bacteria had positive feedback in at least one of the PGP trait tests. The mesophiles scored poorly in the increasing temperatures test, revealing the potentially enhanced traits of the thermotolerant bacteria. DNA sequencing revealed that all the thermotolerant bacteria were classified to Bacillus spp genus. In vitro trials revealed the potential of these strains to improve the tolerance of crops to different abiotic stressors (drought, salinity, temperature) (Maitra et al., 2021). Following the cultivation of thermotolerant bacteria under controlled conditions, the highest growth rate ranged between 40oC-55oC, while some of them were still growing at 65oC (Fig 1A). Regarding the microcosm studies, the CO_2 emissions of thermotolerant inoculated soil plots were almost two times higher than the plots containing the mesophiles, three days after the inoculation (Fig. 1B). Our preliminary findings provide some insights on the enhanced adaption and possible contributions of thermotolerant compared to mesophilic bacteria, outlining the need for further research.

16:40 María Teresa Salido, Ana González Robles, Kiriaki Varikou, Antonios Nikolakakis, Vasiliki Chatziieremia, Ioanna Manolikaki, Lea-Melissanthi Ventoura, Spyros Liapakis, Konstantinos Tzerakis, Theodoros Aggelioudakis, Panagiotis Petrakis, Panagiotis Koulelis, Alexandra Solomou, Evangelia Avramidou, Georgios Vasilakis, Sotiris Theodorakopoulos, Vasileios Gkisakis, Asimoula Kardimaki, Rubén Tarifa, Pedro Rey, Francisco Valera and Georgios Koubouris

Olivares Vivos- Biodiversity As Added Value In Agriculture. From Ecosystem Services To Commercial Differentiation In The Case Of Greece

PRESENTER: Vasiliki Chatziieremia

ABSTRACT. LIFE Project Olivares Vivos+ (LIFE20 NAT/ES/001487) (hereafter OV+), is a demonstrative project that aims to replicate in main olive growing European Mediterranean countries, an innovative biodiversity friendly olive farming model, based in an agri-environmental scheme. It is designed by a previous LIFE project Olivares Vivos in Andalusia (southern Spain). A scientifically based certification for biodiversity recovery was developed to transfer the added value of this farming model to extra virgin olive oils, crossing thus the market. The aim is to conserve nature by integrating biodiversity into the profitability of olive production. This is achieved not only by improving the market position of oils that support biodiversity, but also by reducing economic costs through oil models that benefit from biodiversity (fewer agrochemical inputs and more ecosystem services provided by biodiversity). OV+ biodiversity monitoring uses the common protocols developed by previous OV project and evaluates abundance and biodiversity of several indicator groups sensible to agriculture management and landscape simplification. It takes into consideration different trophic levels such as: herbaceous and woody vegetation (by vegetation sampling squares); ants and spiders (both captured with pitfall traps); insect pollinators (captured in floral patches); birds (visually and audibly detected) and bats (calls collected by Audiomoths and subsequent recognition by

machine learning). Here it is presented the Greek preliminary information of biodiversity. Each of these groups has been surveyed seasonally. The surveys took place at two olive farms in continental Greece in the Peloponnese (Kakkavas and Koukounara villages) and two island olive farms in Crete (Kolymbari and Stavies villages). We observed a notable diversity of each group in olive farms of Greece, recording 759 total taxa (277 plants species, 65 ant's species, 134 insect pollinators species, 135 spiders Genera, 105 bird's species and 43 bats species). Using non-metric multidimensional scaling (stress < 0.20), it is further showed an apparent segregation of these taxa between continental and island Greece. This could be explained by the high degree of endemicity of Crete species, mainly in arthropods species, as well as some differences related with complexity of landscape and the intensification of the agriculture practices. Accordingly, some recommendations are proposed for these olive groves to recovery biodiversity. These include implementing sustainable ground herb cover management such as mowing instead of recurrent tillage and herbicide use. Additionally, the reforestation of hedgerows with native woody species to increase landscape connectivity and complexity at the farm scale. Eventually, OV+ is an innovative agricultural model of great demonstrative value, which not only halts the loss of biodiversity but also recovers the flora and fauna that have traditionally live with the olive grove. This project exhibited that it is possible to increase the profitability of olive groves by recovering biodiversity. This research is funded by: LIFE Olivares Vivos + Increasing the impact of Olivares Vivos in the EU, Reference: LIFE20 NAT/ES/001487

17:00-17:30 Coffee Break

17:30-19:30 Session S6: Soil Microbiome Applications: Soil health restoration and/or plant growth promotion

CHAIRS: *Ana Alexandre* and *Ehaliotis Constantinos*
LOCATION: Amphitheater Aristotle

17:30 *Panos Moschou*

Paths affecting root paths

ABSTRACT. Plant roots have an astonishing ability to survey their environment. For example, when they encounter rocky soils, they can rapidly change their architecture in order to adapt. These changes depend on mechanoperceptive events that are an essential part of the root life cycle. Yet, the underlying mechanoperceptive mechanisms that help roots perceive their

environment are far from understood. I will thus discuss a recent discovery of our group in which we showed that root cells have certain mechanoperceptive proteins. These proteins can form droplets at the plasma membrane, so-called “biomolecular condensates” with the ability to crosstalk with specific lipids. Furthermore, I will briefly discuss how these proteins can relay signals in root cells to affect root architecture. Finally, I will argue that these are not only curiosity-driven findings; they can also help us in developing applications relevant to soil management that I will succinctly discuss.

18:15 *Nikolaos Kaloterakis*, *Andrea Braun-Kiewnick*, *Adriana Giongo*, *Mehdi Rashtbari*, *Bahar S. Razavi*, *Doreen Babin*, *Kornelia Smalla*, *Rüdiger Reichel* and *Nicolas Brüggemann*

Can the application of plant growth promoting Bacillus pumilus alleviate the early growth reduction in successively grown winter wheat?

PRESENTER: *Nikolaos Kaloterakis*

ABSTRACT. Introduction Winter wheat (WW) is one of the most important crops worldwide. Therefore, farmers have been increasing the share of WW in their crop rotations. However, self-succession of WW leads to a significant yield decline. This is often attributed to the soil-borne fungus Gaeumannomyces graminis var. tritici (Ggt; take-all) causing earlier root senescence. This decline is observed even in years without pronounced Ggt presence in the soil. This suggests a moderating role of rotational position-specific microbial community in biomass build-up of WW. At the same time, there is increasing interest in harnessing the beneficial properties of plant growth promoting bacteria to enhance plant health and productivity. The potential of using such beneficial rhizobacteria to alleviate biomass reduction in successive WW rotations is substantial. In this experiment, we aimed to investigate this potential by seed-inoculating WW plants with Bacillus pumilus.

Methods After seed inoculation, plants were grown for 40 days (until end of tillering) in new temperature-regulated rhizoboxes in an outdoor space, subjected to natural fluctuation of environmental conditions. WW was grown in soil after oilseed rape (W1) and soil after one season of WW (W2). When the plants were harvested, we employed zymography to quantify the activity and hotspot area in the rhizosphere of beta glucosidase and leucine aminopeptidase. We further employed glucose imaging to quantify glucose release in the rhizosphere of the plants.

We measured soil mineral N, microbial diversity indices as well as microbial community composition. Special focus was also given to root plastic responses as a function of the microbial inoculant and WW rotational position

Results W1 outperformed W2 in biomass accumulation during early growth and this was mainly evident for root growth. Successively grown WW had a much lower root growth, compared to WW grown after oilseed rape and Bacillus pumilus application exerted a strong influence in the root growth patterns of W2. This led to the full alleviation of the growth reduction in W2. W1 did not appear to benefit from the addition of Bacillus pumilus, highlighting its role on shaping the microbial composition and function in the rhizosphere of W2.

18:35 *Myrto Tsiknia*, *Georgios Leventis*, *Dimitra Stathopoulou*, *Cleopatra Garezou*, *Georgios Petrakis* and *Constantinos Ehaliotis*

Ecosystem and biodiversity restoration of degraded landscapes in dry-land conditions, novel tools and practices: the case study of quarries restoration in Milos island

PRESENTER: *Myrto Tsiknia*

ABSTRACT. In arid ecosystems, native plant species and their associated microbial communities are co-adapted under harsh conditions, like water scarcity, high temperatures and low soil-fertility. These plant-microbe relationships can influence soil functions, enhancing plant resilience to arid conditions. Anthropogenic degradation of terrestrial ecosystems, like quarrying activities, disrupt natural habitats and degrade soil quality, adding an extra pressure to these ecosystems, that challenges their ecological stability. The restoration of such degraded soil ecosystems focuses mainly on the selection of appropriate plant species, with priority given to the use of native plant species compatible with the composition of the plant communities surrounding the area to be restored. However, the reproduction of native plants and their successful re-establishment presents significant technical difficulties. The sterile soil deposits of quarries, poor in organic matter and nutrient content, with lack of structure and low water holding capacity, make plant reestablishment extremely difficult, undermining the reestablishment of natural plant communities, soil biodiversity and soil functions. In recent years, approaches to the soil-plant system have changed radically. We understand plants as symbiotic habitats of soil microbial communities, which play a key role in their growth and survival. In this context, novel microbiome-based restoration technologies are emerging as promising solutions. These technologies utilize plant-growth-promoting microorganisms to enhance soil recovery, restore plant biodiversity, and improve ecosystem stability and accelerate the recovery of arid ecosystems in post-quarrying landscapes. Furthermore, harnessing the potential of native plant species and their microbiomes offers a sustainable pathway for ecological restoration, fostering resilience in disturbed landscapes. Future research should focus on optimizing these microbiome-based technologies, exploring their potential for broader applications in restoring disturbed ecosystems beyond quarrying sites.

18:55 Simon Lewin, Niklas Plag, Carolina Leoni and Doreen Babin

Multiphasic approach to identify efficient bacterial inoculants to support soil and crop health under field conditions

PRESENTER: Simon Lewin

ABSTRACT. Globally 90% of soils are prone to degradation until 2050 1. The sustainable development goals 2, 13, and 15 demand a transition to sustainable agroecosystems to ensure ecosystems services and functions of soils, secure food security and mitigate climate change. Soil microbiomes aid several ecosystem services like organic matter decomposition, nutrient cycling, pest regulation and soil structure. Intensive agricultural management based on frequent tillage, synthetic inputs and only few crop species reduces microbial diversity in soils and therefore endangers soil health and crop performance. The Pampa biome covers the largest natural grasslands of South America (70×106 ha) exhibiting a distinguished diversity in fauna and flora. The region has a long history in livestock production, while during the last two decades substantial areas were transformed into arable lands, threatening aboveground and soil biodiversity. Two long-term experiments in the Uruguayan Pampa region have evaluated effects of a) reduced tillage and fertilizer type on degraded soils from continuous vegetable horticulture (Las Brujas) and b) pasture-crop rotations of varying intensity (Treinta y Tres Palo a Pique) on non-degraded soils. Improvements in yield and soil health such as soil aggregation were achieved by conservation agriculture2. Microbial beta-diversity and differential abundant taxa responded to changes in agricultural management3,4. However, the linkage of the microbiome to soil and plant health needs to be better understood, so that microbial inoculation

can be harnessed for a sustainable agriculture. From a bacterial isolate collection obtained at both LTEs in previous sampling campaigns, we aim to identify efficient microbial isolates and consortia for improving soil health and crop performance. In order to achieve this in vitro characterization by assaying among others indole-3-acetic acid and siderophore production as plant beneficial traits was performed. Amplicon sequencing of marker genes allows the characterization of entire microbial communities. The identification of microbial key members in a cultivation- independent manner by multi-kingdom network analyses as well as a machine learning approach is currently in progress. These key members will be mapped to the 16S rRNA gene sequence of each isolate obtained by Sanger sequencing. Thus, bacterial isolates with the verified plant beneficial traits and the ability to emerge in the native- on-site microbiome will be identified. In a next step we aim to characterize the microbial isolates with a potential keystone role in silico by whole genome sequencing and utilizing the plant-associated bacteria database (PLaBA-db)5. Eventually, promising isolates will be selected based on the in silico and in vitro characterization. These isolates will be combined in consortia to verify their rhizosphere competence and keystone role in the microbiome in the greenhouse and under field conditions. Thus, efficient microbial isolates and consortia for improving soil health and crop performance will be identified.

19:15 *Christina Nikolaou*, *Myrto Tsiknia*, *Antonios Apostolakis*, *Dionisios Gasparatos* and *Constantinos Ehaliotis*

Linkages between the Acemannan concentration and the Composition of Plant-Associated Microbial Communities in Aloe vera (Aloe Barbadensis Miller) under increased soil salinity

PRESENTER: *Christina Nikolaou*

ABSTRACT. Acemannan, a polysaccharide with many pharmaceutical uses, is a secondary metabolite in the gel tissue of Aloe vera (Aloe Barbadensis Miller) leaves. In the gel tissue, acemannan serves primarily for water storage promoting therefore drought tolerance. Soil salinization can alter the composition and functionality of plant-associated microbial communities responsible for nutrient cycling in soils and it can potentially impact plant nutrition and secondary metabolism. In the present study, we examined the effects of increased levels of soil salinity on the concentration of acemannan, on plant nutrient acquisition, on soil properties

and processes and on plant-associated belowground microbial communities in young Aloe vera plants grown in a coastal region in Greece. Microbial community profiles were determined with amplicon sequencing via Illumina MiSeq platform (2x300bp) in bare and rhizospheric soil, as well as in Aloe vera roots, targeting the 16S rRNA gene (for the prokaryotic community), the ITS2 region (for the fungal community). We focused on the examination of potential links between changes in soil nutrient status, plant characteristics and microbial community composition under increased salinity. We found significant covariations between the euclidean distances of acemannan accumulation with the differentiations in the rhizospheric prokaryotic communities and endoroot fungal communities for the plants grown under high, but not under low salinity. We further explored for direct and indirect effects of salinity on acemannan concentration using structural equation modelling (SEM). SEM showed that salinity may causes shifts in microbial community composition that positively affected acemannan accumulation. Further studies should attempt to elucidate the mechanisms by which soil salinity affects acemannan concentration in Aloe vera leaves.